



Critical Letters in Economics & Finance

Volume 1 | Issue 1

Article 1

2020

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Recommended Citation

Morales, Lucía and Andreosso-O'Callaghan, Bernadette (2020) "Covid19: Global Stock Markets “Black Swan”,” *Critical Letters in Economics & Finance*: Vol. 1: Iss. 1, Article 1.

Available at: <https://arrow.tudublin.ie/clef/vol1/iss1/1>

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Covid-19 - Global Stock Markets “Black Swan”

Lucía Morales¹✉, Bernadette Andreosso-O'Callaghan²

Abstract

Global financial markets have entered a state of collective hysteria triggered by the Coronavirus (Covid-19) detected in Wuhan, China in December 2019 suggesting that Covid-19 is a financial market “black swan” event. The impact of Covid-19 on the world’s leading stock markets is examined with the help of spectral causality and the well-known Granger causality model. The core research findings indicate that markets did not react to volatility levels exhibited by the Shanghai stock market, with China being identified as the epicentre of the virus outbreak. Markets awoke to the virus global threat when Italy registered its first cases, with the Italian stock market being the one that activated European fears. Global uncertainty escalated to reach a global financial dimension with global markets entering in free fall by the end of February 2020 due to the lack of active and coordinated responses from politicians and monetary authorities.

Keywords: Covid-19, Black Swan, Global Stock Markets, Causality, Volatility.

1. Introduction

The World Health Organization (WHO, 2020) reported on the 7th of March 2020 that COVID-19 surpassed 100,000 confirmed cases with positive news showing that the spread of the virus can be slowed down if universally applicable actions on health care are taken and carefully followed by the population. While the world is facing unprecedented times surrounded by significant levels of ambiguity and indecision, positive news is coming from China that broadcasts a clear message of stability. Beijing is sensing that Covid-19 is under control as the country is reporting very low numbers in daily new infections (including Wuhan) since early March 2020 (South China Morning Post, 10 Mar, 2020). As the WHO continues offering advice and encouraging countries to make efforts to control the disease; epidemiologists, researchers and health professionals are battling the pandemic and trying to gain time to develop effective treatments and vaccines; at the same time, global political leaders are disappointing by their lack of clarity on how to deal with the virus.

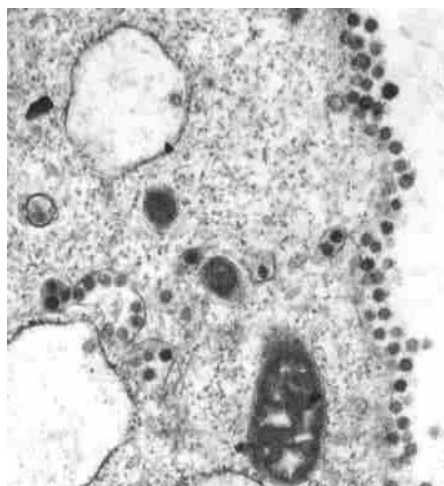


Figure 1: Coronavirus

(Source: World Health Organization (2020)-

Coronavirus from SARS isolated in FRhK-4

cells available at: <https://www.who.int/csr/sars/coronavirus/en/>

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Countries' leaders are not able to react in a coordinated and organised manner to Covid-19 health threats. The lack of united actions that seek to control the propagation of the virus have pushed global stock markets into panic and collective hysteria registering a black week on Monday 9th and Thursday 12th March, 2020³ with global stock markets plummeting.

This critical letter offers preliminary insights into stock market reactions to Covid-19, by examining its causal effects and volatility dynamics. The study makes an original research contribution due to the evolving nature of the crisis.

The analysis considers three different scenarios: 1. Causal effects from the Shanghai stock exchange to the world global markets as Covid-19 epicentre was located in a pedestrian market in Wuhan, China. 2. Causal effects from the Italian stock market, as the world is now facing a pandemic that has materialised as a real threat to global economic and financial stability. 3. Volatility impact captured by the VIX Index to gain insights into the global dimension of the health crisis. The outlined scenarios help gaining an understanding of global stock markets dynamics in the context of Covid-19 - a "black Swan".

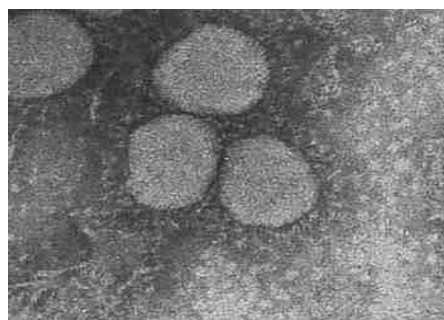


Figure 2: Coronavirus (Source: World Health Organization (2020)- Coronavirus from SARS isolated in FRhK-4 cells available at: <https://www.who.int/csr/sars/coronavirus/en/>)

2. Global Stock Markets Reaction to COVID-19

Global stock markets appeared to enjoy some level of stability at the start of the year 2020 with positive trends that were disrupted by the emergence of Covid-19 – as a "black swan" that has shaken up the world stock markets and that is compromising the stability of the global economy. Financial markets "black swans" are described as rare and highly disruptive events. The "black swan" theory was introduced by Taleb (2007), where the author explains that "black swan" events exhibit three main characteristics: a) a black swan is considered an outlier event, which is an unprecedented and/or unexpected event; b) a black swan has substantial influence on related events and things; c) people rationalising the black swan event with oversimplified explanations (Lin and Tsai, 2019). The outlined features are undoubtedly linked to the global reaction to Covid-19.

Table 1: Stock Markets Returns 9th, 12th, 16th & 18th March 2020

Countries	9 th March	12 th March	16 th March	18 th March
China - Shanghai Se A Share	3.05%	1.53%	3.46%	1.85%
France - CAC 40	8.76%	13.10%	5.92%	6.12%
Germany - Dax 30	8.28%	13.05%	5.45%	5.73%
Hong Kong - Hang Seng	4.32%	3.72%	4.12%	4.27%
Italy- FTSEMib	11.85%	18.54%	6.30%	1.28%
Japan - Nikkei 225	5.20%	4.51%	2.49%	1.69%
Spain - IBEX 35	8.30%	15.15%	8.21%	3.50%
United Kingdom - FTSE100	8.00%	11.51%	4.09%	4.13%
United States Dow Jones Indus.	8.11%	10.52%	13.84%	6.51%
United States S&P 500 Composite	7.90%	9.99%	12.77%	5.32%
United States NASDAQ Composite	7.57%	9.91%	13.15%	4.82%

Core stock markets registered historical losses amid fears of the global pandemic signalling a severe shock to the global economy.

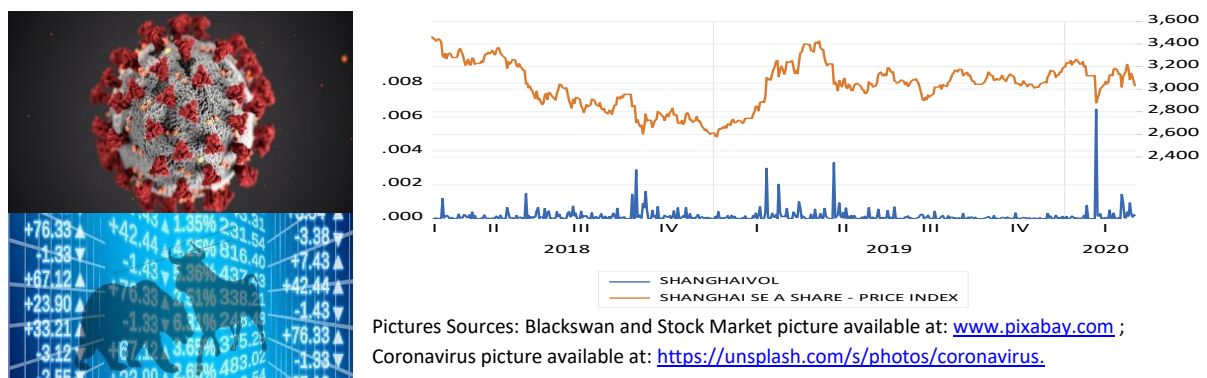
There is questioning about China's response to the outbreak, as some concerns regarding its international approach have been raised. Chinese authorities claim that their response was a swift one and that the existence, virulence and highly contagious effects of the virus were properly communicated

³ See table 1 below for details on stock returns performance.

to the global community projecting an image of political and economic stability. While China focus on showing to the world its perceived effective strategy to handle Covid-19, American and European stock markets have entered into turmoil as a “black swan” shadow has eclipsed them – “black swans” are considered as unlikely events that occur and have a considerable impact due to a lack of preparation. Furthermore, “black swans” are identified as events that can reverse the return rate of an investment from positive to negative and they are associated with significant levels of market uncertainty (Adams and Thornton, 2013; Aleskerov and Egorova (2012), as those exhibited by key global stock markets since the virus landed in Europe. Unfortunately, the lack of solidarity among EU countries is showing - once again - that these countries are not able to cope with the health crisis, adding growing shadows of doubt to the European project due to European leaders' inability to deal with ever increasing challenges. The lack of preparedness to deal with the pandemic in some EU countries is acknowledged and this is in part a result of budgetary cuts imposed upon these countries before and after the 2008 global financial crisis; for example the Italian, French and Spanish health systems are failing to deal with increasing numbers of affected people and to provide health system workers with basic equipment to protect themselves exacerbating the transmission of the virus.

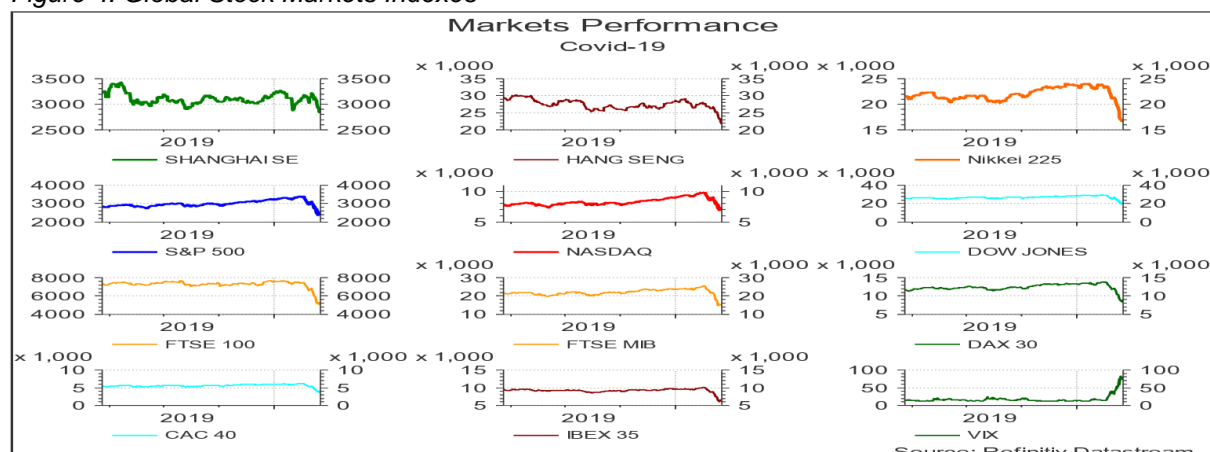
Global economies have failed to study and assess China's actions to make quick moves that aimed to curtail the progression of Covid-19, and on the 9th of March 2020 global stock markets registered significant falls in returns showing the investors community concerns on how the health crisis is being managed. On one hand, the Shanghai Se A Share Index is showing signs of recovery as returns dropped less than 5% during March 2020 black week. On the other hand, global markets were hit in a harsh manner as they reacted to plunging oil prices due to evolving events between Russia and Saudi Arabia (key oil exporting countries) as Riyadh's have deep concerns on the raising presence and influence of Russia in the Middle East that contributed to fuel the global market hysteria.

Figure 3: Covid -19 and the Shanghai SE A Price Index and Volatility



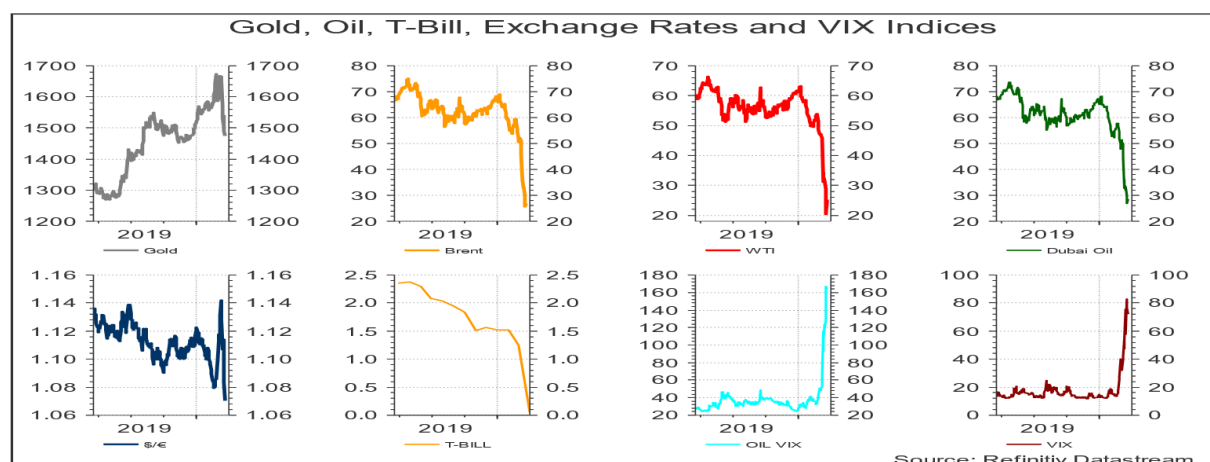
As the world faces an unprecedented health crisis, the world stock markets dynamics are showing that the investor community is spooked by unfolding events on the management of the spread of the Covid-19. Russia's decision not to join the OPEC oil markets generated further uncertainty due to the breakdown between Russia and other major producers that lead to the biggest plunger on oil prices. An unparallel oil price war unveiled as Russia declined to join OPEC curbing oil production in the wake of weakened demand. Saudi Arabia fired back by slashing its oil prices and entering into a price war with Russia that led to major falls in global stock market indexes and that were followed suit by gold prices, treasury rates and the upsurge of volatility as reflected on the VIX index (see figure 4 and 5 below and figure 7 in the appendix).

Figure 4: Global Stock Markets Indexes



The combination of events led to the US oil prices dropping too and with US Treasury yields following suit, a situation that contributed to the formation of a perfect storm that dragged stock markets and that was reflected in raising levels of stocks and oil volatility indexes (BIS, 2020). Investors are reacting strongly to fears of a global economic recession led by Covid-19 and fuelled by the world major oil exporting countries confrontation. Gold prices took their historical safe haven role as investors tried to react to global uncertainty by pushing gold prices up, but the upward trend was disrupted on the 9th of March 2020, as emerging oil prices news sent gold prices in downfall leaving investors puzzled by unfolding events.

Figure 5: Key Financial Indicators



3. Findings Critical Insights

The core research findings from the implemented causality analysis on volatility show how Shanghai does not report evidence of significant causal effects in the studied global stock markets, being the Italian stock market index the one that exhibited a short term impact on key global stock markets that appeared to be the trigger and channel for the global turmoil. The outcomes from the spectral causality test offered insights on stock markets volatility dynamics indicating that the Shanghai Se A shares index had a short term impact on global markets during the early days of the outbreak and disconnected from global panic tendencies as the country started to stabilise and control the spread of the virus.

Table 2: Causality Findings

	Cac40	Dax30	Dow Jones	FTSE100	Hang Seng	Ibex35	Nasdaq	Nikkei225	S&P500	Shanghai	FTSEMib
Granger Causality (Volatility)											
	Cac40	Dax30	Dow Jones	FTSE100	Hang Seng	Ibex35	Nasdaq	Nikkei225	S&P500	Shanghai	FTSEMib
Shanghai	No	No	No	No	No	No	No	No	No	n/a	No
FTSEMib	Yes	No	Yes	No	No	Yes	No	Yes	Yes	No	n/a
VIX	Yes	Yes	No	Yes	No	Yes	No	No	No	No	Yes
Spectral Causality (Volatility)											
	Cac40	Dax30	Dow Jones	FTSE100	Hang Seng	Ibex35	Nasdaq	Nikkei225	S&P500	Shanghai	FTSEMib
Shanghai	Yes	Yes	No	No	Yes	No	Yes	Yes	No	n/a	Yes
FTSEMib	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	n/a
VIX	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	n/a	Yes

*Details on the implemented methodological framework are available in the appendix (see page 7 to 14).

The global economy is facing a situation of significant social unrest that might exacerbate as political leaders take controversial decisions that are stimulated by a lack of strategy and clarity to deal with the virus, with some general examples offered below:

- Italy's initial decision to confine more than 16 million people with the aim of restricting movement led to significant levels of confusion about the country's efforts to try to curtail the spread of the virus ending up in a situation affecting the whole country.
- The US administration started to show its lack of strategy when dealing with major cruise line operations. Princess Cruises reported health problems long before the back to back outbreaks of the new coronavirus on the Diamond and Grand Princess ships. The US government is failing to formulate standard protocols to deal with the outbreaks on cruise ships and in land cases that are escalating, and with reported cases of people infected across at least 31 states. Furthermore, the country is under severe criticism due to the lack of appropriate testing and management of the virus outbreak and because of its delayed and uncoordinated response across the country in similar fashion to the European situation.
- Many countries such as Israel, Italy, Spain and so on started to impose restrictions on mass gatherings and denied entry/re-entry to foreign nationals who have been in several Covid-19 affected countries. In some cases, these measures have proved to be ineffective due to the lack of cooperation from the population leading towards even more restrictive approaches.
- Spanish and French health workers' voiced concerns about their role to spread the virus as they are forced to work long shifts under inadequate protection measures; the authorities of these countries have failed to supply the required material to hospitals and health workers that are becoming a source of contagion.

Covid-19 might lead towards significant policy mistakes as countries try to deal with the virus outbreak. The combination of the health crisis and oil prices shocks could trigger a global economic recession that could help China to reposition its global economic strategy and to strengthen its growing role in the international economic system as the world dependency on China's supplies is staggering and is clearly reflected in the lack of equipment and basic supplies for hospitals (Andreosso-O'Callaghan and Morales, 2019; Morales and Andreosso-O'Callaghan, 2018). On the other hand, this does ultimately put to question the extent and type of the chosen globalisation model with China as the factory of the world, even for sensitive products.

4. Conclusions

China's reaction to Covid-19 has sent a strong message to the world. China is the major supplier of basic equipment to hospitals, and countries such as Spain, France and Italy are facing major problems to equip their health systems. China's approach in terms of crisis management aspires as being seen as very effective, sending thereby a clear image to the world of a country with an economic and political system that was able to counteract high levels of uncertainty. Tight controls applied by political and health authorities have aspired to be seen as effective in ensuring stability during different crises. In the world most developed economies, evidence shows that fragile mechanisms have impacted severely on the functioning of health systems, with phases of containment and its damaging impact on the economy. Because of China's inability to divulge the true extent of the damage and because of the inability of Western leaders to devise a cooperative and coordinated strategy, the pandemic is translating gradually into yet another world recession. In particular, the US and the EU as a whole have shown inadequate responses and a lack of engagement at the global level at times when international coordination and global cooperation is much needed.

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Appendix

Econometric Modelling Brief Insights

Table 3: Data Notation

Research Sample	Countries	Returns	Volatility
SHANGHAI SE A SHARE - PRICE INDEX	China	SHANGHAIR	SHANGHAIVOL
FRANCE CAC 40 - PRICE INDEX	France	CACR	CAC40VOL
DAX 30 PERFORMANCE - PRICE INDEX	Germany	DAXR	DAX30VOL
HANG SENG - PRICE INDEX	Hong Kong	HANGSENGR	HANGSENGVOL
FTSE MIB INDEX - PRICE INDEX	Italy	MIBR	FTSEMIBVOL
NIKKEI 225 STOCK AVERAGE - PRICE INDEX	Japan	NIKKEIR	NIKKEI225VOL
IBEX 35 - PRICE INDEX	Spain	IBEXR	IBEXR35VOL
FTSE 100 - PRICE INDEX	UK	FTSER	FTSER100VOL
S&P 500 COMPOSITE - PRICE INDEX	US	SP500R	SP500VOL
DOW JONES INDUSTRIALS - PRICE INDEX	US	DOWR	DOWVOL
NASDAQ COMPOSITE - PRICE INDEX	US	NASDAQR	NASDAQVOL
CBOE SPX VOLATILITY VIX (NEW) - PRICE INDEX	US		

Data Frequency: Daily; Time Period: 1st December 2019 – 9th March 2020; Observations: 71. Data Source: DataStream.

Methodology

1. Descriptive statistics were generated to examine the series mean values, standard deviations and normality properties. Correlations were estimated (see table 4 below) showing lower correlations between chosen markets and the Shanghai SE A Share and the Hang Seng Index. Since the outbreak of the Health Crisis, China's Shanghai stock market has kept some level of stability when compared to the world stock markets panic reaction.
2. Commonly applied time series testing for stationarity were conducted to ensure that the series under study complied with time series basic properties so that the causality framework could be implemented. A VAR(p) model was employed to select the appropriate number of lags to be used leading to a VAR(2) outcome. The AIC criteria was chosen as the sample size under study is small. The research sample under study consists on a representation of 11 stock markets, data frequency is daily and the time period under study spans from 1st December 2019 to 9th March 2020 counting for 71 observations.
3. A causality framework was chosen, as the purpose of the research study was to identify causal effects from the Shanghai stock exchange that captures global market reaction to Covid-19, as the virus outbreak took place in Wuhan, China. The Italian stock exchange was selected to identify if global markets reacted to developments in China or if pandemic fears were triggered by unfolding events in Italy. The VIX was selected as a proxy to capture stock markets causal effects due to increasing levels of uncertainty. The selected research framework was based on the implementation of bidirectional causality tests where spectral causality allowed to capture market dynamics. While the Granger causality test offered a static dimension that complemented and helped to cross check the core research findings. The discussions are focused on unidirectional causal effects as the aim of this paper is to examine causal effects from the Shanghai Se A Share Index, The FTSE MIB index and the VIX index.

Table 4: Stock Markets Returns - Correlations

	CACR	DAXR	DOWR	FTSER	HANGSENGR	IBEXR	MIBR	NASDAQR	NIKKEIR	SHANGHAIR	SP500R
CACR	1.00										
DAXR	0.96	1.00									
DOWR	0.76	0.73	1.00								
FTSER	0.96	0.92	0.77	1.00							
HANGSENGR	0.53	0.53	0.34	0.55	1.00						
IBEXR	0.97	0.95	0.78	0.93	0.48	1.00					
MIBR	0.94	0.93	0.70	0.88	0.51	0.93	1.00				
NASDAQR	0.77	0.73	0.96	0.77	0.34	0.79	0.73	1.00			
NIKKEIR	0.62	0.62	0.50	0.64	0.65	0.57	0.53	0.47	1.00		
SHANGHAIR	0.30	0.31	0.25	0.32	0.46	0.28	0.23	0.17	0.52	1.00	
SP500R	0.78	0.74	0.99	0.79	0.34	0.79	0.72	0.98	0.49	0.23	1.00

1. Granger Causality Spectral Causality Modelling

The well-established Granger Causality test (Granger 1969) was implemented, where two stationary variables are regressed against each other in two separate equations.

$$y_t = \alpha_1 + \sum_{i=1}^n \beta_i x_{t-i} + \sum_{j=1}^m \gamma_j y_{t-j} + \varepsilon_{1t} \quad (1)$$

$$x_t = \alpha_2 + \sum_{i=1}^n \theta_i x_{t-i} + \sum_{j=1}^m \delta_j y_{t-j} + \varepsilon_{2t} \quad (2)$$

where y_t is a dependent variable and x_t is an independent variable regressed against y_t . The outcomes for unidirectional causality were considered in this paper as the aim of the paper was to identify if Covid-19 generated causal effects focused on three explanatory variables (Shanghai SE A Share Index, FTSE MIB and VIX). The results from this analysis are presented in table 5 below.

The implemented frequency domain model is based on a bivariate approach that allowed considering the three scenarios under study where Shanghai se A Share was the first scenario to test as Covid-19 first cases were reported in Wuhan, China. The second scenario examined the impact of Italy and the third scenario look at global uncertainty where the VIX index was selected as an appropriate proxy. A bivariate causality analysis in the context of the frequency domain brings further evidence to the indexes' behaviour over the sample period. The study by Breitung and Candelon (2006) is based on earlier work by Geweke (1982) and Hosoya (1991) that considered the two-dimensional vector containing Y_t and X_t with a finite-order VAR representative of order p ,

$$\Theta(L) \begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \begin{pmatrix} \Theta_{11}(L) & \Theta_{12}(L) \\ \Theta_{21}(L) & \Theta_{22}(L) \end{pmatrix} \begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \varepsilon_t \quad (3)$$

where, $\Theta(L) = I - \Theta_1 L - \dots - \Theta_p L^p$ is a 2x2 lag polynomial and $\Theta_1, \dots, \Theta_p$ are 2x2 autoregressive parameter matrices, with $L^k X_t = X_{t-k}$ and $L^k Y_t = Y_{t-k}$. The error vector ε_t represents white noise with zero mean and $E(\varepsilon_t \varepsilon_t') = \Sigma$, where Σ is positive and finite. The MA representative of the system is

$$\begin{pmatrix} Y_t \\ X_t \end{pmatrix} = \psi(L) \eta_t = \begin{pmatrix} \psi_{11}(L) & \psi_{12}(L) \\ \psi_{21}(L) & \psi_{22}(L) \end{pmatrix} \begin{pmatrix} \eta_{1t} \\ \eta_{2t} \end{pmatrix} \quad (4)$$

with $\psi(L) \eta_t = \Theta(L)^{-1} G^{-1}$ and G is the lower triangular matrix of the Cholesky decomposition $G'G = \Sigma^{-1}$ such that $E(\eta_t \eta_t') = I$ and $\eta_t = G \varepsilon_t$. The causality test developed by Geweke (1982) can then be written as:

$$M_{X \Rightarrow Y}(\gamma) = \log \left[1 + \frac{|\psi_{12}(e^{-i\gamma})|^2}{|\psi_{11}(e^{-i\gamma})|^2} \right] \quad (5)$$

Within this framework, no Granger causality from X_t to Y_t with a frequency γ corresponds to the condition $|\psi_{12}(e^{-i\gamma})|^2 = 0$. Breitung and Candelon's (2006) main contribution is to show that this condition leads to

$$|\theta_{12}(e^{-i\gamma})| = |\sum_{k=1}^p \theta_{k,12} \cos(k\gamma) - i \sum_{k=1}^p \theta_{k,12} \sin(k\gamma)| = 0, \quad (6)$$

where, $\theta_{k,12}$ is the (1,2) element of θ_k , such that a sufficient set of conditions for no causality is given by

$$\sum_{k=1}^p \theta_{k,12} \cos(k\gamma) = 0 \text{ and } \sum_{k=1}^p \theta_{k,12} \sin(k\gamma) = 0 \quad (7)$$

Hence, we can test the null hypothesis of no Granger causality with a frequency γ using a standard F-test for the linear restrictions imposed by the VAR representative of order p , which follows an $F(2, T-2p)$ distribution for every γ between 0 and π , where T is the number of observations in the series (Breitung and Candelon, 2006). The outcome of the spectral causality testing is presented on table 5 below and on figures 8 to 10.

Table 5: Granger Causality and Spectral Causality on Volatility

	Cac40	Dax30	Dow Jones	FTSE100	Hang Seng	Ibex35	Nasdaq	Nikkei225	S&P500	Shanghai	FTSEMib
Granger Causality (Volatility)											
Shanghai	No (0.99)	No (0.96)	No (0.71)	No (0.98)	No (0.91)	No (0.95)	No (0.96)	No (0.96)	No (0.96)	n/a	No (0.94)
FTSEMib	Yes (0.00)*	No (0.62)	Yes (0.00)*	No (0.30)	No (0.27)	Yes (0.00)*	No (0.01)*	Yes (0.00)*	Yes (0.01)*	No (0.94)	Yes n/a
VIX	Yes (0.00)*	Yes (0.09)*	No (0.62)	Yes (0.00)*	No (0.43)	Yes (0.00)*	No (0.59)	No (0.59)	No (0.58)	No (0.14)	Yes (0.05)*
Spectral Causality (Volatility)											
	Cac40	Dax30	Dow Jones	FTSE100	Hang Seng	Ibex35	Nasdaq	Nikkei225	S&P500	Shanghai	FTSEMib
Shanghai	Yes	Yes	No	No	Yes	No	Yes	Yes	No	n/a	Yes
FTSEMib	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	n/a
VIX	Yes	Yes	No	Yes	No	Yes	Yes	No	Yes	n/a	Yes

*1%, **5%, ***10% significance level, p-values are presented in brackets. See figures 8 to 10 for spectral causality graphical outcomes.

Figure 6: Global Price Indexes

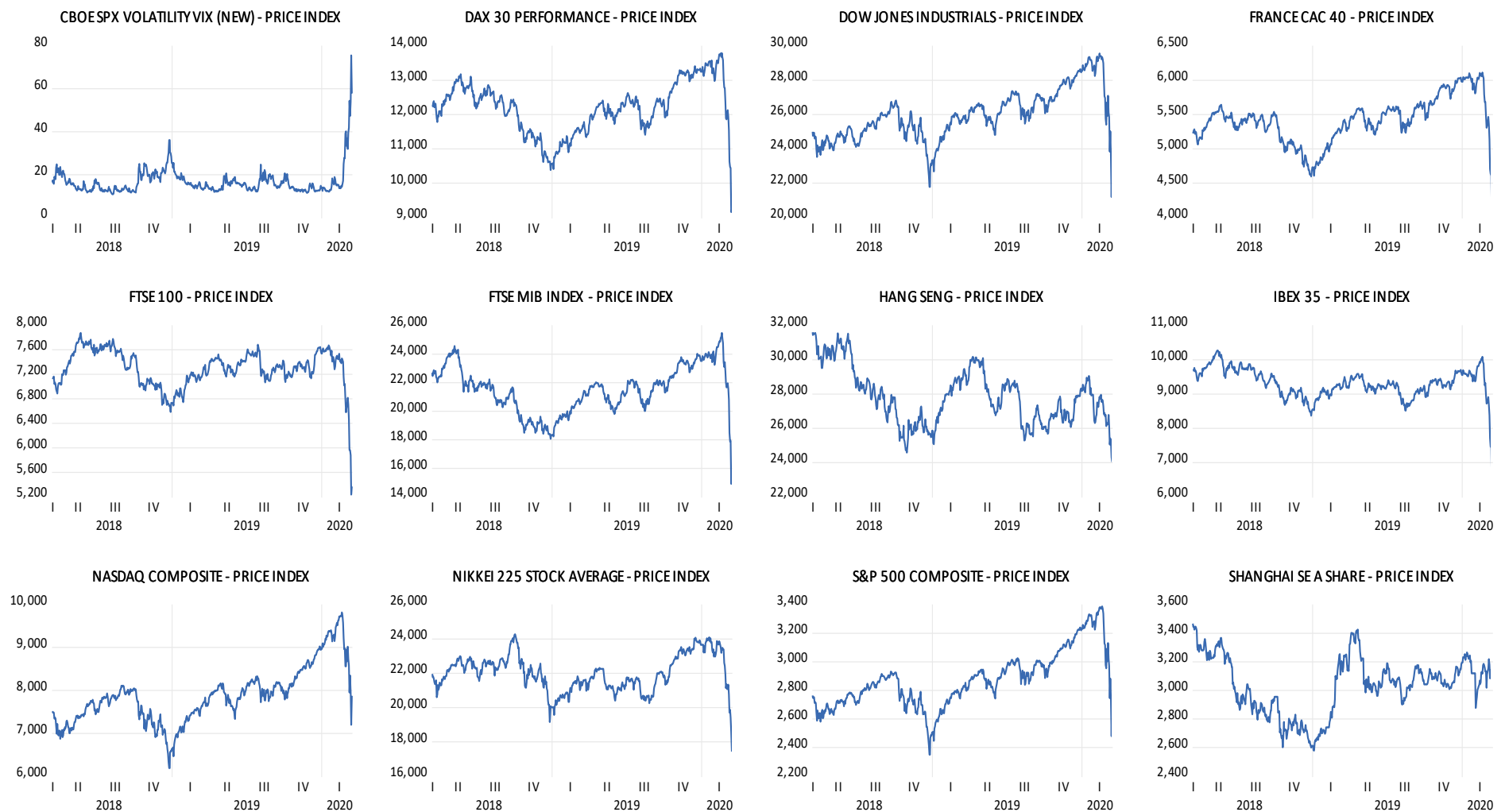


Figure 7: Stock Markets Volatility

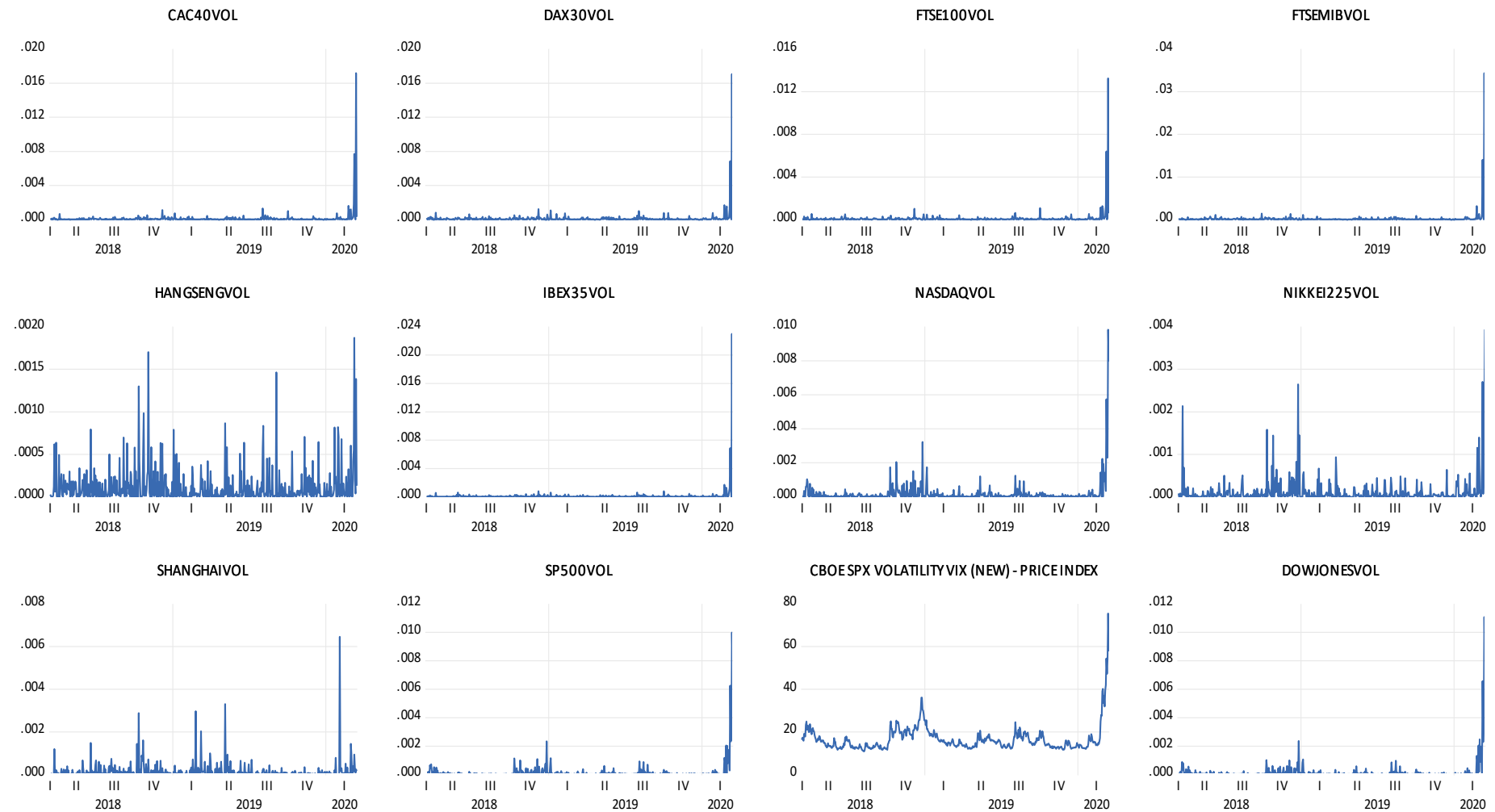


Figure 8: Spectral Causality Results

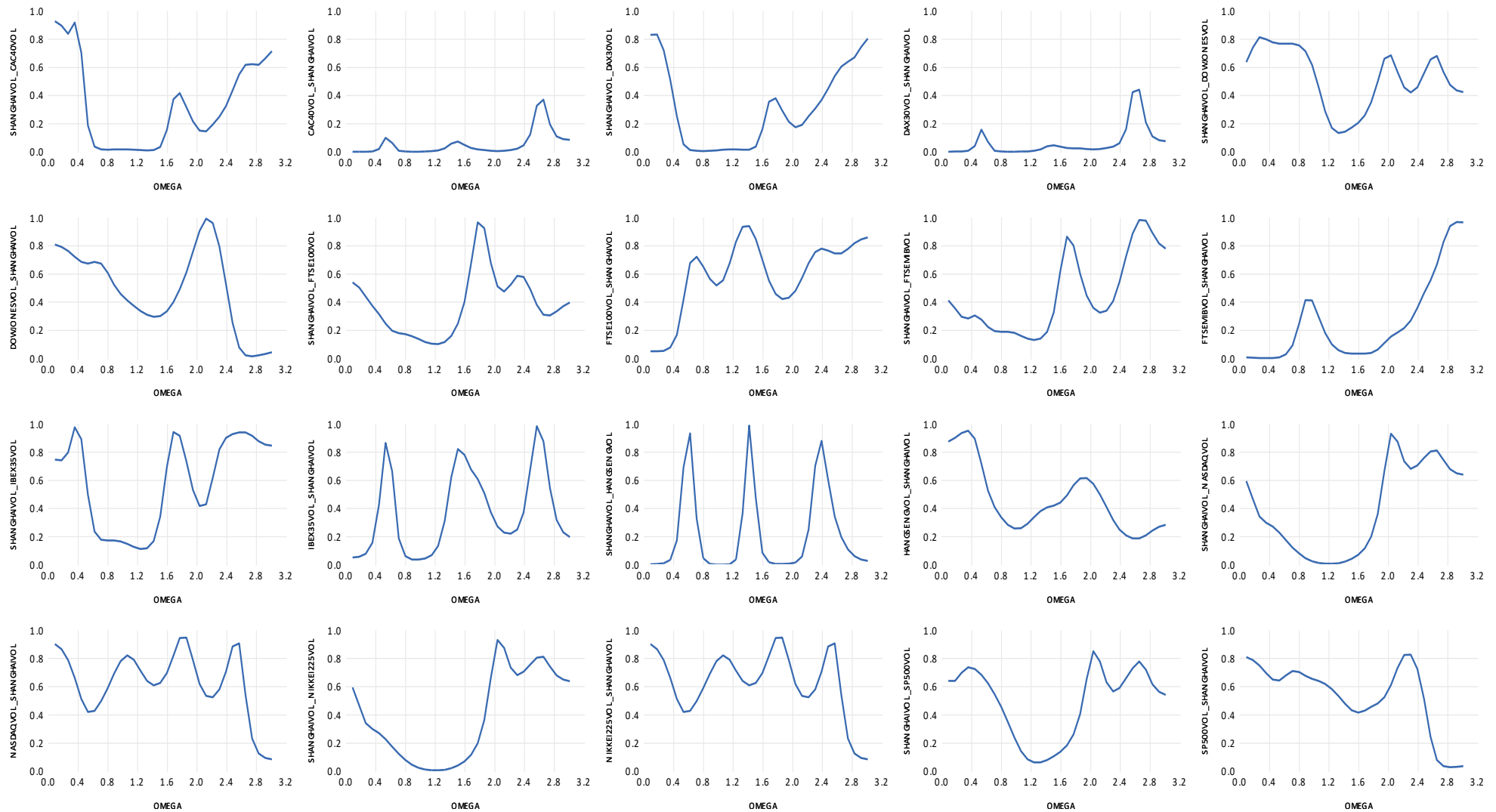


Figure 9: Spectral Causality Results

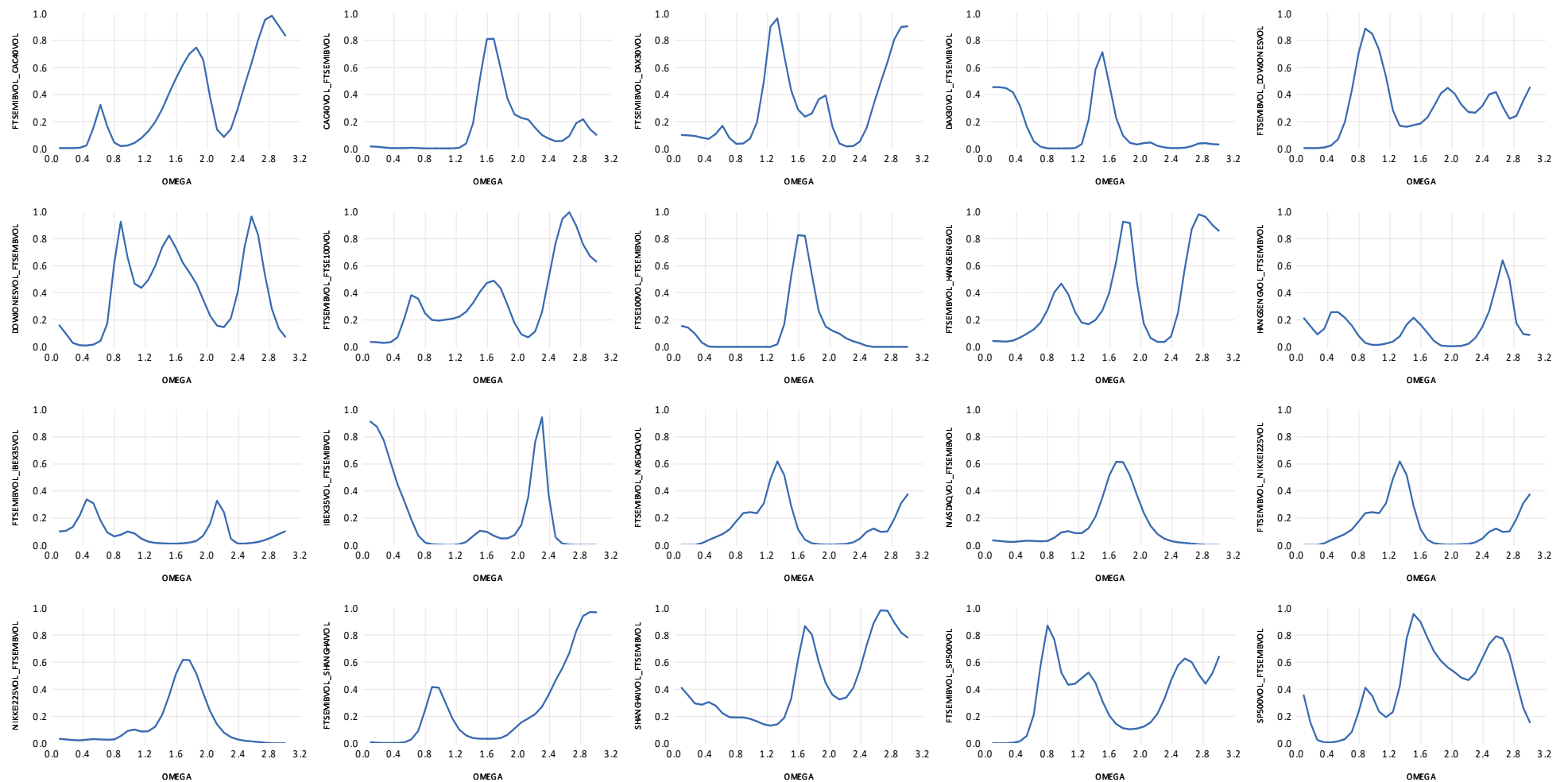


Figure 10: Spectral Causality Results

